

Coastal and halophytic habitats and their flora in Evrotas Delta (SE Peloponnisos, Greece)

GEORGIOS KORAKIS^{1*} and ACHILLEAS GERASIMIDIS²

¹ Department of Forestry, Environment and Natural Resources, Democritus University of Thrace,
P.O. Box 129, Pantazidou 193, 68200, Orestiada, Greece

² School of Forestry and Natural Environment, Aristotle University,
P.O. Box 270, 54124, Thessaloniki, Greece

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This paper studies the flora and the habitats of the Evrotas Delta in SE Peloponnisos (Greece). The study area comprises a combination of coastal and wetland ecosystems with vegetation that depends largely on soil-water conditions, and consists of a mosaic of wetland, halophytic and psammophytic plant communities. Field studies recorded 136 plant taxa (belonging to 109 genera and 38 families) specialized or related to azonal habitats. These taxa, found in nine mapped coastal or wetland habitats, are described fully and classified into phytosociological units of high taxonomic rank. Life form and chorological spectra, indication of life-form, chorological data and concise notes on species biotopes are provided.

Key words: wetlands, habitat types, coastal and halophytic plant communities.

INTRODUCTION

The Evrotas Delta is located in SE Peloponnisos in the inlet of the Lakonikos Gulf (Fig. 1). The delta was formed from the shifting and deposition of sediment transported by the river Evrotas, the delta's major water contributor. The delta is a natural formation that comprises a wide variety of coastal and wetland ecosystems. This biodiversity is reflected in an equally varied and well-conserved flora and fauna, which resulted in the inclusion of the area into the Natura 2000 Network. The delta formation provides habitats for rare species such as the loggerhead sea turtle *Caretta caretta*, which nests in the sandy beaches, the otter *Lutra lutra*, and the jackal *Canis aureus*. Additionally, due mainly to its location on a bird migration route, the area is the most significant resting and feeding ground in southern Greece for a large number of migratory birds.

This paper aims to present the first complete inventory and maps of the natural habitats and flora of the Evrotas Delta.

* Corresponding author: tel.: +30 2310 334980, +30 25520 41155, fax: +30 25520 41192, e-mail: gkorakis@fmenr.duth.gr, giorgoskorakis@yahoo.gr



FIG. 1. The study area of the Evrotas Delta in SE Peloponnisos (Greece).

MATERIALS AND METHODS

Investigated area

Location, geology and soil

The study area contains the delta formation of the Evrotas estuary and the “Valtaki” wetland, situated a few kilometers west of the area. The delta has a total surface area of 75 km² and its outlet to the sea is 15 km in length (Kakouros, 2000).

The substrate of the delta formations comprises mainly Quaternary deposits. These are Holocene deposits composed of alluvium transported downstream by river torrents and floods, and in some areas are rich in fine sand, clay and gravel material. Presently, the area is characterized by low rates of sediment deposition due to its prevailing mild inclines and the technical constructions on the watershed's upstream areas (Kakouros, 2000).

Wetland habitats in the inner delta have clayey-loam or loamy-clay soils, with relatively low sand content. Organic soils often develop in anaerobic conditions due to long-term flooding and salt deposits can be observed on the surfaces of low level soils (sea-level or lower) due to the presence of seawater in the groundwater. Additionally, a wide zone behind the coastal sand dunes is affected by salt deposits carried by the wind, as demonstrated by the presence of obvious toxic reaction marks on tree leaves. This phenomenon is found at further distances from the coast in areas where the sand dunes have been destroyed or eroded.

The delta's deposits extend seawards via a coastal zone of sand deposits. This zone is a narrow strip of land, 0.3-0.7 Km wide and *ca.* 11 km long. The substrate here is generally sandy and unstable, but in some areas characteristic sand dunes develop with various degrees of stability.

Climate and bioclimate

The area's climate is classified based on meteorological data provided by the Elos Meteorological Station

TABLE 2. Basic climatic characteristics of the study area (source: Kakouros, 2000)

Climatic characteristic	Value
Mean annual precipitation	613.4 mm
Maximum mean monthly precipitation	169.8 mm
Minimum mean monthly precipitation	0 mm
Maximum monthly precipitation	229.2 mm
Minimum monthly precipitation	0 mm
Maximum monthly temperature	28°C
Minimum monthly temperature	7.7°C
Annual temperature range	15.52°C
Mean annual days with snowfall	1.4
Mean annual days with frost	8.9
Hail frequency	very rarely
Prevailing winds	N & S

of the Ministry of Agriculture. The Meteorological Station of Elos is located at the boundary of our study area, on the outskirts of Elos village and 10 m a.s.l. Table 1 presents the mean temperature and precipitation values of the area, while its climatic characteristics are shown in Table 2.

The ombrothermic diagram (Fig. 2) of the Elos station was compiled from its precipitation and temperature data. The diagram shows that the study area has a long dry period and, based on the above data, the area's climate is characterized as thermo-Mediterranean. According to the Koeppen system of climatic classification, the area's climate falls into the Csa type of Mediterranean climate with very warm, dry summers and mild winters.

According to Mavrommatis (1980) methodology, the bioclimate of the study area is Mediterranean with a mild thermo-Mediterranean character. The xerothermic index is $100 < x < 125$, which indicates that the biologically dry days number between 100 and 125. The area belongs to the semi-arid bioclimatic layer with warm winter and a mean minimum temperature of the coldest month greater than 7°C ($m > 7$; m = minimum monthly temperature).

TABLE 1. Mean temperature (T, °C) and precipitation (P, mm) values as recorded at the Elos Meteorological Station for the period 1972-1997 (source: Kakouros, 2000)

	J	F	M	A	M	J	J	A	S	O	N	D
T	9.71	9.78	11.31	14.22	18.15	22.49	25.05	25.23	22.9	18.78	14.53	11.32
P	93.6	78.1	65.6	39.6	15.5	5.6	8.7	9	16	68.7	96.7	115.9

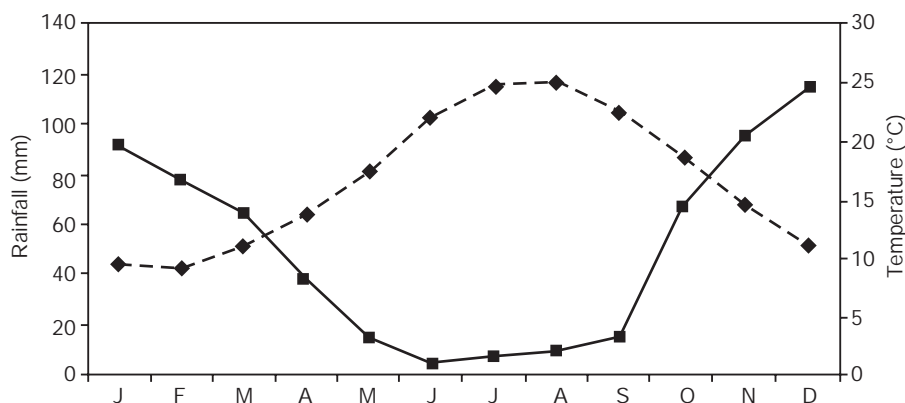


FIG. 2. Ombrothermic diagram of Elos meteorological data.

Vegetation

The Evrotas delta is located within the Oleo-Ceratonion subzone, which belongs to the wider Mediterranean Quercetalia ilicis vegetation zone. However, the study area's vegetation should not be assigned to the above subzone as it is to a high degree azonal and as such not climate-dependent, but rather dependent on the prevailing local substrate conditions (humidity and texture of the soil).

Intensive human activity is evident within the study area. Citrus and olive cultivations are especially lucrative due to the abundance of plains and water. During recent decades, land use has changed and the conversion of natural land to agricultural has resulted in the loss of natural habitats in large parts of the delta formation.

Floristic and habitat research

The floristic research and habitat recording were undertaken in the spring and summer of 1998. The plant specimens were identified in the Laboratory of Forest Botany and Geobotany, Aristotle University of Thessaloniki, and taxa nomenclature followed that by Strid & Tan (1997, 2002), Greuter *et al.* (1984-1989), and Tutin *et al.* (1968-1980, 1993). Life-form classification followed the Raunkier's (1934) system and was based on the works of Garcke (1972), Pignatti (1982) and Oberdorfer (1990). For the chorological types, Pignatti's (1982) classification in combination with Tutin *et al.* (1968-1980, 1993) were used. Habitat distinction, identification and classification were based on the characteristic and diagnostic taxa referred to in Lavrentiades (1964, 1971), Horvat *et al.* (1974), Babalonas (1979), Dimopoulos *et al.* (1995), Mucina (1997), Dafis *et al.* (1999, 2001) and Sýkora *et al.* (2003). The corresponding habitat coding provided,

follows the European Union typology (Devillers & Devillers, 1996; Dafis *et al.*, 1999, 2001).

RESULTS AND DISCUSSION

Within the study area we identified nine habitat types that depended on the prevailing abiotic conditions, mainly humidity, salinity and soil texture. As to the underlying substrate, we distinguished habitats of sandy coasts, saline soils, and fresh-brackish water. These habitats occurred in the study area as scattered "islands" of the vegetation patchwork and are described in detail below (Fig. 3). It should be noted that the ecology and dynamics of the four identified sand-dune habitats have been also discussed by Lavrentiades (1964, 1971, 1975), Babalonas (1979), Voliotis & Drossos (1983) in related studies of several Greek coasts. In addition, Sýkora *et al.* (2003) present a comprehensive classification of the coastal strandline and sand-dune vegetation of Greece.

Habitat types

1. Embryonic shifting dunes

EU Habitat Code: 2110

Cakiletea maritimae Tx. et Preising ex Br.-Bl. et Tx. 1952 &

Ammophiletea Br.-Bl. et Tx. ex Westhoff *et al.*, 1946

This habitat type includes the low sand dunes of the shoreline. These dunes are the first elevations (fore-dunes) of loose sandy substrate found behind the bare outwash zone of the winter surf and comprise the first evolutionary stage of the sand dune system. They are characterized by the presence of organic material and plant remains washed up by the sea and also by incessant mobility and changing of the shape,

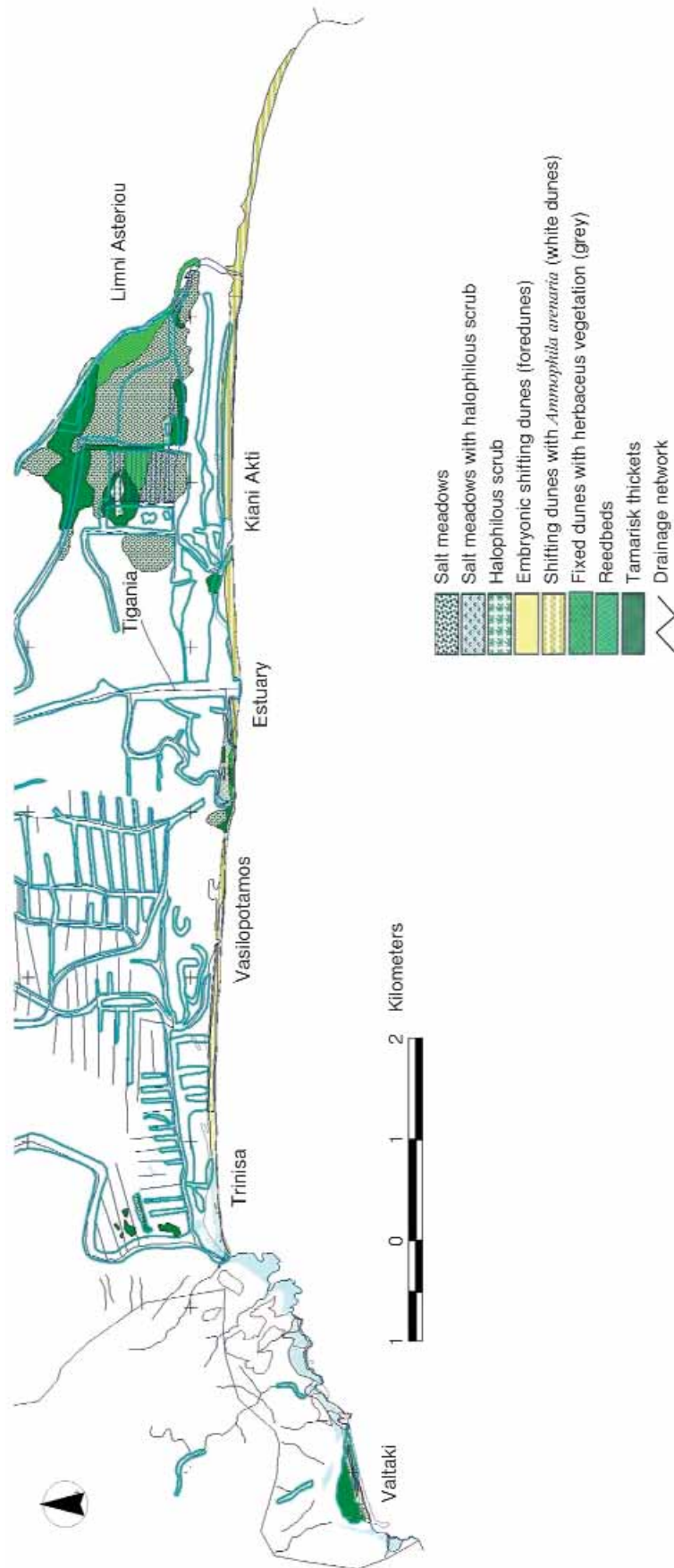


FIG. 3. Map of habitat types.

which ensure their low height (< 1 m) and sparse vegetation cover.

Within this unstable environment pioneer communities develop containing characteristic and diagnostic taxa of the classes: a) Cakiletea, which includes psammonitrophilous taxa sporadically grown within the outwash zone and b) Ammophiletea, which includes typical psammophytes. Most common are: *Cakile maritima*, *Salsola kali*, *Xanthium strumarium*, *Euphorbia peplis*, *Elymus farctus*, *Sporobolus pungens*, *Eryngium maritimum*, *Cyperus capitatus*, *Anthemis tomentosa*, *Ammophila arenaria* and *Pancratium maritimum*.

Habitats of this type are found along the western area of the coast. They extend to the east from Trinisa in a zone of 3-3.5 km length and 50-100 m width, and the heights of the sand dunes are ca. 0.5 m. They are often degraded due to the pressure of summer bathers. They also appear in the Valtaki area in a 10 m-wide zone.

2. White shifting dunes with *Ammophila arenaria*

EU Habitat Code: 2120

Ammophiletea Br.-Bl. et Tx. ex Westhoff *et al.*, 1946

This habitat type comprises shifting sand dunes that grow to large heights; over 4 m in the study area. Despite the fact that the floristic composition of this plant community contains more or less the same taxa as the embryonic shifting dunes, the white shifting dunes are characterized by large populations of marram grass, *Ammophila arenaria* that colonizes the tops of the sand dunes. The first important step in the dune stabilization process is happening here because *Ammophila arenaria* has the ability to develop an extensive root system that acts as an internal mesh within the dunes. This community remains relatively open and sandy areas between marram tufts are colonized by other psammophytic species and locally, in the hollows of the dunes, by the tall caespitose grass *Saccharum ravennae*. Taxa of this habitat are characteristic of the Ammophiletea: *Elymus farctus*, *Medicago marina*, *Silene colorata*, *Sporobolus pungens*, *Eryngium maritimum*, *Cyperus capitatus*, *Anthemis tomentosa*, *Ammophila arenaria*, *Pancratium maritimum*, *Euphorbia paralias* and *Euphorbia peplis*.

This habitat type completely covers the coastal zone from the Vasilopotamos estuary to the eastern border of the study area and the outskirts of Kokkinia settlement. The width of the white dune zone is large, 60-120 m, and dunes have heights ranging from 1.5 to 5 m.

3. Fixed dunes with herbaceous vegetation (grey dunes)

EU Habitat Code: 2220

Ammophiletea Br.-Bl. et Tx. ex Westhoff *et al.*, 1946

These are stabilized inland sand dunes that succeed the shifting dunes. Within the grey dunes, the stability of the sandy substrate is attained through the development of a permanent vegetation cover by annual and perennial herbaceous plants, woody species and lichens. Dune stability is also aided by an increase in organic matter content that improves water retention and soil cohesion, and changes the colour of the dune (hence the name grey dunes).

Within the study area, the natural succession of the sand dune ecosystems has been disturbed by human activities, and the grey dunes are now found in their typical form in a few limited areas. Their natural location behind the white dunes has been greatly reduced due to the expansion of cultivated land and illegal building. We observed this habitat in two areas (the Valtaki area, and between Vasilopotamos and the Evrotas riverbed) with a very diverse flora including many invaders from neighbouring disturbed grounds or cultivated habitats. Most common are: *Anagallis foemina*, *Trifolium angustifolium*, *Avena sterilis*, *Bromus hordeaceus*, *Hordeum murinum*, *Juncus conglomeratus*, *Lagurus ovatus*, *Silene colorata*, *Petrohragia dubia*, *Cynosurus echinatus*, *Briza maxima*, *Erodium cicutarium*, *Matricaria recutita*, *Nerium oleander* and *Vitex agnus-castus*.

4. Dune sclerophyllous scrubs

EU Habitat Code: 2260

Quercetea ilicis Br.-Bl. ex A. De Bolós Y Vayreda, 1950

This habitat contains formations of evergreen sclerophyllous scrubs of the thermo-Mediterranean zone that develop on stabilized dunes. This shrubby vegetation attains a height of 1-3 m in a dense unbroken canopy that is cushion-formed due to sea winds. It is observed on the crest of the sand dunes, immediately behind the ammophilous vegetation and represents the final stage of the succession in the vegetation of sand dunes. The vegetation in this type is the climax of the whole "psammose" (Lavrentiades, 1964, 1971) and comprises characteristic taxa of the Quercetea ilicis with dominant *Pistacia lentiscus* and the accompanying taxa *Ceratonia siliqua*, *Smilax aspera*, *Myrtus communis*, *Prasium majus*, *Calicotome villosa*, *Rubus sanctus*, *Clematis flammula*, *Vitex agnus-castus*

and *Pyrus spinosa*. We observed this habitat type on the coast in the area of Valtaki.

5. Salt meadows

EU Habitat Code: 1410

Juncetea maritimi Tx. et Oberd., 1958

This habitat type is characterized by the presence of *Juncus acutus* ssp. *acutus* and *Juncus maritimus*. These taxa withstand high soil humidity and for this reason grow in drenched and/or periodically submersed soils. However, the habitat finds its ecological optimum in sites occurring at least a few centimetres higher than the average soil water level. In the study area, it grows in scattered inland sites where soil levels are higher than those of the halophilous scrubs. Regarding salinity, this habitat forms a transitional stage between saltpans with exclusive halophytes and habitats lacking halophytic vegetation. This is because it develops on lighter soils compared to the heavy, loamy-clays of the halophilous scrubs, and as such is less influenced by the underground sea water level and more influenced by the fresh groundwater of winter rains and floods.

We observed salt meadows on the south of the Asteri settlement in areas where vegetation comprises a mosaic of reeds, halophilous scrubs and *Tamarix* thickets. For this reason in some areas the vegetation was mapped as a complex of habitats.

The vegetation of this habitat is composed of *Juncus acutus* ssp. *acutus*, *Juncus maritimus*, *Limonium gmelinii*, *Hordeum marinum*, *Suaeda splendens*, *Aster tripolium* and scattered *Tamarix* species, but in higher, dryer sites, increased populations of grasses such as *Hordeum marinum*, *Bromus hordeaceus*, *Lagurus ovatus*, *Phalaris coeruleascens*, *Polypogon maritimus*, prevail and close to the fringes several introduced ruderals such as *Dittrichia viscosa*, can be seen.

This habitat type also occurs sporadically in low areas behind the white dunes. These hollows (dune slacks) are often flooded in winter or spring, but the water table remains close to the surface all year long. These conditions are ideal for the development of wet meadows with dominant taxa *Juncus acutus* ssp. *acutus*, *Juncus maritimus* and *Saccharum ravennae*.

6. Halophilous scrub

EU Habitat Code: 1420

Salicornietea fruticosae Br.-Bl. et Tx. ex A. de Bolós Y Vayreda, 1950

The halophilous scrub contains precursor communities of perennial exclusive halophytes. They occur in

low sites with very mild or no inclines where the loamy-clay saline soils are influenced by the rise of the water table via capillary action. These communities undergo continuous succession as the plants are able to retain mud with their vegetative parts thus gradually raising the soil level. This process, together with the annual increase of organic matter, alters the water level conditions and allows the colonization of new taxa even in a year-to-year period.

Within this habitat type, plant cover alternates with bare ground that, in areas of high salinity, is covered with crystallized salt. The high ecological specialization of the halophytes results in their presence as faces.

Characteristic taxa of the halophilous scrub include the cushion-formed (40-50 cm tall) subshrub *Sarcocornia fruticosa*, and *Sarcocornia perennis*, *Salicornia europaea*, *Atriplex portulacoides*, *Suaeda splendens* and *Puccinellia distans*, accompanied by *Limonium gmelinii*, *Juncus maritimus*, *Polypogon maritimus* and *Hordeum marinum*. This habitat type occurs in small patches mainly around the Tigania area.

7. Saline tamarisk thickets

EU Habitat Code: 92D0

Nerio-Tamaricetea Br.-Bl. et O. de Bolós, 1958

This habitat contains *Tamarix smyrnensis* and *Tamarix hampeana* thickets. *Tamarix* species exhibit wide ecological tolerance to their development conditions as they grow on soils of varying humidity and salinity, and form climax communities in wetlands. However, in each case, site parameters define the composition of the stand's understorey.

Within the Evrotas Delta, this habitat has been disrupted in many small thickets due to repeated logging and burning that aimed to extend pasture and agricultural land. In areas where the stands are conserved, they have dense canopies and impenetrable understoreys dominated by *Rubus sanctus*. In sites with altitudes lower than sea level, the taxa *Juncus maritimus*, *Polypogon maritimus* ssp. *maritimus*, *Limonium gmelinii*, *Hordeum marinum* and *Phragmites australis* are present. In higher areas, *Rubus sanctus*, *Pistacia terebinthus* and *Dittrichia viscosa* were observed.

8. Reed beds

EU Habitat Code: 72A0

Phragmito-Magnocaricetea Klika in Klika et Novák, 1941

The habitat contains colonies of tall swamp plants growing in still, fresh or semi-brackish water. Within

the study area, colonies of *Phragmites australis* and *Typha domingensis* develop in the Limni Asteriou area. They are also seen growing along the area's riverbeds, channels and drained ditches with *Scirpus holoschoenus* and *Iris pseudacorus*.

9. *Salix alba* and *Populus alba* galleries

EU Habitat Code: 92A0

Salicetea purpureae Moor, 1958

This type of vegetation is found growing along the Evrotas riverbed in areas with *Salix alba*, *Salix fragilis* and their hybrids. These trees are found sporadically, singly, or in loose thickets, between colonies of *Phragmites australis*, *Typha domingensis* and *Arundo donax*. Within this habitat the presence of *Platanus orientalis* and *Populus alba* is very rare.

Floristic catalogue

Pteridophyta

EQUISETACEAE

Equisetum ramosissimum Desf. – G rhiz, Circumbor. – Tamarisk thickets.

Equisetum variegatum Schleicher – G rhiz, Circumbor. – Wet ground in dune slacks.

Gymnospermae

PINACEAE

Pinus halepensis Miller subsp. *halepensis* – P scap, Steno-Medit. – Planted along constructed road in backdunes near Kiani Akti.

Pinus pinea L. – P scap, Euri-Medit. – Planted along constructed road in backdunes near Kiani Akti.

Dicotyledoneae

ANACARDIACEAE

Pistacia lentiscus L. – P caesp, S-Medit.-Macarones. – Dune sclerophyllous scrub, tamarisk thickets, Valtaki.

APOCYNACEAE

Nerium oleander L. – P caesp, S-Medit. – Grey dunes of Valtaki, Evrotas riverbed.

BORAGINACEAE

Anchusa hybrida Ten. – H scap, Steno-Medit. – Disturbed grey dunes.

Myosotis ramosissima Rochel subsp. *ramosissima* – T scap, Europ.-W-Asiat. – Salt meadow transitions in Trinisa.

Nonea pulla (L.) DC. – H scap, E-Europ. – Salt meadow disturbed ground.

CARYOPHYLLACEAE

Petrorhagia dubia (Rafin.) G. López & Romo – T scap, S-Medit. – Salt meadow transitions to cultivated land, grey dunes.

Silene colorata Poiret – T scap, Steno-Medit. – White and grey dunes near Vasilopotamos.

CHENOPODIACEAE

Atriplex portulacoides L. = *Halimione portulacoides* (L.) Aellen – Ch frut, Atl. – Salt meadows, dune slacks.

Salicornia europaea L. – T scap, Cosmop. – Halophilous scrub, close to Kiani Akti.

Salsola kali L. – T scap, Paleotemp. – Foredunes, dune slacks.

Salsola soda L. – T scap, Paleotemp. – Halophilous scrub, salt meadows.

Sarcocornia fruticosa (L.) A. J. Scott – Ch succ, Medit. – Halophilous scrub in Tigania.

Sarcocornia perennis (Miller) A. J. Scott – Ch succ, Euri-Medit. – Halophilous scrub in Tigania.

Suaeda splendens (Pourret) Gren. & Godron – T scap, Medit. – Halophilous scrub in Tigania, salt meadows, tamarisk thickets.

COMPOSITAE

Anthemis tomentosa L. subsp. *tomentosa* – T scap, Medit. – White dunes.

Aster tripolium L. – T scap, Eurasiat. – Salt meadows near Tigania.

Calendula arvensis L. – T scap/H bienn, Euri-Medit. – Salt meadows, disturbed ground.

Crepis capillaris (L.) Wallr. – T scap, Centro-Europ. – Salt meadows.

Dittrichia viscosa (L.) Greuter – H scap/NP, Euri-Medit. – Salt meadows, disturbed dunes by road construction, near Evrotas estuary.

Helichrysum microphyllum (Willd.) Camb. = *Helichrysum italicum* (Roth) Don – Ch suffr, S-Europ. – White dunes.

Leontodon tuberosus L. – H ros, Steno-Medit. – Transitional meadows.

Matricaria recutita L. = *Chamomilla recutita* (L.) Rauschert – T scap, Subcosmop. – Transitional meadows, grey dunes, Trinisa.

Senecio vulgaris L. – T scap, Euri-Medit. – Grey dunes, Valtaki.

Tolpis barbata (L.) Gaertner – T scap, Steno-Medit. – Transitional meadows.

Tragopogon sinuatus Avé-Lall – T scap/H bienn, Steno-Medit. – Salt meadows, transitional ground.

Xanthium strumarium L. subsp. *strumarium* – T scap, Steno-Medit. – Dunes of various types, disturbed ground.

CRUCIFERAE

Cakile maritima Scop. – T scap, Atl. – Foredunes, white dunes.

DIPSACACEAE

Knautia integrifolia (L.) Bertol. subsp. *integrifolia* – T scap, Euri-Medit. – Grey dunes.

EUPHORBIACEAE

Euphorbia paralias L. – Ch frut, Euri-Medit.-Atl. – White dunes.

Euphorbia peplis L. – T rept, Medit. – Foredunes.

GERANIACEAE

Erodium cicutarium (L.) L' Hér. – T caesp/H ros, Euri-Medit. – Grey dunes and meadows.

Geranium dissectum L. – T scap, Eurasiat. – Grey dunes.

Geranium molle L. ssp. *molle* – T scap, Eurasiat. – Dune slacks.

LABIATAE

Phlomis fruticosa L. – NP, Steno-Medit. – Dune sclerophyllous scrub, Valtaki.

Prasium majus L. – Ch frut, Steno-Medit. – Dune sclerophyllous scrub, understorey, Valtaki.

LEGUMINOSAE

Acacia cyanophylla Lindley – P scap, Austral. – Planted along constructed road in backdunes near Kiani Akti.

Astragalus spruneri Boiss. – H ros, Sub-Balk. – Grey dunes.

Calicotome villosa (Poiret) Link – NP, Steno-Medit. – Dune sclerophyllous scrub, Valtaki.

Ceratonia siliqua L. – P scap, S-Medit. – Dune sclerophyllous scrub, Valtaki.

Hymenocarpus circinnatus (L.) Savi – T scap, Steno-Medit. – Transitional meadows.

Lathyrus hirsutus L. – T scap, Euri-Medit. – Transitional meadows.

Lotus corniculatus L. – H scap, Paleotemp. – Transitional meadows.

Lotus halophilus Boiss. & Spruner – T scap, S-Medit. – In tamarisk thickets.

Medicago marina L. – Ch rept, Euri-Medit. – Dunes of various types.

Medicago polymorpha L. – T scap, Euri-Medit. – Disturbed ground near road construction.

Medicago truncatula Gaertner – T scap, Steno-Medit. – Transitional meadows.

Melilotus indicus (L.) All. – T scap, Medit.-Turan. – Grey dunes.

Onobrychis caput-galli Lam. – T scap, Steno-Medit. – Marginal to grey dunes.

Ononis mitissima L. – T scap, Steno-Medit. – Salt meadows and tamarisk thickets.

Ornithopus compressus L. – T scap, Euri-Medit. – Dry, transitional meadows.

Ornithopus pinnatus (Miller) Druce – T scap, Medit.-Atl. – Transitional meadows

Trifolium angustifolium L. – T scap, Euri-Medit. – Grey dunes.

Trifolium campestre Schreber – T scap, W-Paleotemp. – Transitional meadows.

Trifolium lappaceum L. – T scap, Euri-Medit. – Dry, transitional meadows.

Trifolium nigrescens Viv. – T scap, Euri-Medit. – Transitional meadows.

Trifolium resupinatum L. – T rept, Paleotemp. – Dune slacks, Vasilopotamos, Valtaki.

Vicia hirsuta (L.) S. F. Gray – T scap, Paleotemp. – Dry, transitional meadows.

Vicia lutea L. – T scap, Euri-Medit. – Dry meadows near Trinisa.

Vicia pannonica Crantz – T scap, Euri-Medit. – Transitional meadows.

Vicia sativa subsp. *cordata* (Hoppe) Batt. – T scap, Medit.-Turan. – Dune slacks.

Vicia sativa subsp. *nigra* (L.) Ehrh. – T scap, Medit.-Turan. – Grey dunes.

Vicia villosa Roth subsp. *villosa* – T scap, Euri-Medit. – Transitional meadows.

LYTHRACEAE

Lythrum junceum Banks & Solander – T scap/Hscap, Stenomedit.-Macarones. – Evrotas riverbed.

MYRTACEAE

Myrtus communis L. – P caesp, Steno-Medit. – Dune sclerophyllous scrub, Valtaki.

PAPAVERACEAE

Papaver rhoeas L. – T scap, E-Medit. – Disturbed ground, margins of salt meadows.

PITTOSPORACEAE

Pittosporum tobira (Thunb.) Aiton fil. – NP, E-Asiat. – Planted along constructed road in backdunes near Kiani Akti.

PLANTAGINACEAE

Plantago lagopus L. – T ros, Steno-Medit. – Dry meadows.

PLATANACEAE

Platanus orientalis L. – P scap, SE-Europ. – Evrotas riverbed.

POLYGONACEAE

Emex spinosa (L.) Camp. – T scap, Medit.-Macarones. – Disturbed backdunes.

Rumex bucephalophorus L. subsp. *bucephalophorus* – T scap, Medit.-Macarones. – Tamarisk thickets, near Vasilopotamos.

PLUMBAGINACEAE

Limonium gmelinii (Willd.) O. Kuntze – H ros, Contin. – Salt meadows, marshes near Tigania.

PRIMULACEAE

Anagallis arvensis L. – T rept, Euri-Medit. – Grey dunes.

Anagallis foemina Miller – T rept, Steno-Medit. – Grey dunes.

RANUNCULACEAE

Anemone pavonina Lam. – G bulb, N-Medit. – Transitional meadows.

Clematis flammula L. – P lian, Euri-Medit. – Dune sclerophyllous scrub, Valtaki.

Ranunculus muricatus L. – T scap, Euri-Medit. – Margin of salt meadow, Trinisa.

ROSACEAE

Pyrus spinosa Forskål = *Pyrus amygdaliformis* Vill. – P scap, Steno-Medit. – Dune sclerophyllous scrub, Valtaki.

Rubus sanctus Schreber = *Rubus ulmifolius* Schott – NP, Euri-Medit. – Tamarisk thickets.

Sarcopoterium spinosum L. – Ch frut, SE-Medit. – Transition to rocky shore, Trinisa.

SALICACEAE

Populus alba L. – P scap, Paleotemp. – Evrotas riverbed.

Salix alba L. – P scap, Paleotemp. – Evrotas riverbed, Limni Asteriou, channels.

Salix fragilis L. – P scap, Eurosib. – Evrotas riverbed.

SCROPHULARIACEAE

Linaria pelisseriana (L.) Miller – T scap, Medit.-Atl. – Dry meadows.

Parentucellia viscosa (L.) Caruel – T scap, Medit.-Atl. – Disturbed ground near estuary.

TAMARICACEAE

Tamarix hampeana Boiss. & Heldr. – P caesp/P scap, E-Medit. – Tamarisk thickets.

Tamarix smyrnensis Bunge – P caesp/P scap, E-Medit. – Tamarisk thickets.

UMBELLIFERAE

Daucus guttatus Sm. – T scap, E-Medit. – Transitional meadows.

Eryngium maritimum L. – G rhiz, Atl – White dunes.

Oenanthe pimpinelloides L. – H scap, Medit-Atl. – Dune slacks.

Scaligeria napiformis (Willd. ex Sprengel) Grande – H bienn, E-Medit. – Grey dunes.

Tordylium officinale L. – T scap, NE-Medit. – Dry meadows.

Torilis nodosa (L.) Gaertner – T scap, Medit.-Turan. – Transitional meadows.

VERBENACEAE

Vitex agnus-castus L. – P caesp, Steno-Medit.-Turan. – Dune slacks, Valtaki.

Monocotyledoneae

AMARYLLIDACEAE

Pancratium maritimum L. – G bulb, Medit. – White dunes.

CYPERACEAE

Cyperus capitatus Vandelli – G rhiz, Steno-Medit. – Foredunes and white dunes.

Scirpus holoschoenus (L.) Soják – G rhiz/He, Medit.-Eurasiat. – Channels, close to Limni Asteriou.

IRIDACEAE

Iris pseudacorus L. – G rhiz/He, Paleotemp. – Channels close to Tigania and Limni Asteriou.

JUNCACEAE

Juncus acutus L. subsp. *acutus* – H caesp, Medit. – Salt meadows, tamarisk thickets, Trinisa, Vasilopotamos, Tigania.

Juncus conglomeratus L. – H caesp, Eurosib. – Dune slacks, Valtaki.

Juncus maritimus Lam. – G rhiz, Cosmop. – Salt meadows, in several locations.

LILIACEAE

Smilax aspera L. – P lian, Paleosubtr. – Dune sclerophyllous scrub, Valtaki.

ORCHIDACEAE

Ophrys speculum Link subsp. *speculum* – G bulb, Steno-Medit. – Dry meadows.

Ophrys ferrum-equinum Desf. subsp. *ferrum-equinum* – G bulb, NE-Medit. – Dry meadows.

Orchis lactea Poiret – G bulb, Steno-Medit. – Dry meadows.

Serapias vomeracea (Burm.) Briq. – G bulb, Euri-Medit. – Transitional meadows.

POACEAE

Aegilops lorentii Hochst. – T caesp, Medit. – Disturbed ground.

Aira elegantissima Schur – T caesp, Medit. – Grey dunes.

Ammophila arenaria (L.) Link subsp. *arundinacea* H. Lindb. fil. – G rhiz, Euri-Medit. – White dunes.

Arundo donax L. – G rhiz, Subcosmop. – Margins of salt meadows and reedbeds, Limni Asteriou.

Avena barbata Pott ex Link subsp. *barbata* – T caesp, Euri-Medit.-Turan. – Dry meadows.

Avena sterilis L. – T caesp, Euri-Medit.-Turan. – Grey dunes.

Briza maxima L. – T caesp, Paleosubtrop. – Grey dunes, dry meadows, tamarisk thickets.

Bromus hordeaceus L. subsp. *hordeaceus* – T scap, Subcosmop. – Dry meadows, grey dunes.

Cynosurus echinatus L. – T caesp, Euri-Medit. – Transitional meadows, grey dunes.

Dactylis glomerata L. – H caesp, Paleotemp. – Dry meadows.

Dasypyrum villosum (L.) Borbás – T caesp, Euri-Medit.-Turan. – Transitional meadows.

Elymus farctus (Viv.) Runemark ex Melderis subsp. *farctus* – G rhiz, Medit. – White dunes.

Gaudinia fragilis (L.) P. Beauv. – T caesp, Euri-Medit. – Transitional and wet meadows.

Hordeum marinum Hudson – T caesp, Medit. – Salt meadows, tamarisk thickets, high locations in halophilous scrub, Tigania, Vasilopotamos.

Hordeum murinum L. – T scap, Circumbor. – Salt meadows, grey dunes.

Imperata cylindrica (L.) Raeuschel – G rhiz, Termocsmop. – Salt meadows, dune slacks.

Lagurus ovatus L. – T caesp, Euri-Medit. – Grey dunes, dune slacks, tamarisk thickets, Valtaki, near Evrotas estuary.

Melica ciliata L. – H caesp, Euri-Medit.-Turan. – Disturbed ground, roadsides.

Phalaris coerulescens Desf. – H caesp, Steno-Medit.-Macarones. – Salt meadows, transitional meadows, grey dunes.

Phragmites australis (Cav.) Trin. ex Steudel – He/G rhiz, Cosmop. – In Evrotas riverbed, channels, Limni Asteriou.

Piptatherum coerulescens (Desf.) P. Beauv. – H caesp, Steno-Medit. – Dry meadows.

Polypogon maritimus Willd. subsp. *maritimus* – T caesp, Steno-Medit.-Macarones. – Salt meadows, Trinisa, near Evrotas estuary.

Puccinellia distans (L.) Parl. subsp. *distans* – H caesp, Paleotemp. – Salt meadows and high locations in halophilous scrub, near Tigania.

Saccharum ravennae (L.) Murray – H caesp, Medit.-Turan. – Dune slacks near Evrotas estuary.

Sporobolus pungens (Schreber) Kunth – G rhiz, Subtrop. – Foredunes and white dunes.

Vulpia ciliata Dumort. subsp. *ciliata* – T caesp, Euri-Medit. – Dry meadows.

TYPHACEAE

Typha domignensis (Pers.) Steudel – G rhiz/He, Paleosubtrop. – In reedbeds, Limni Asteriou.

Floristic spectra

Life form spectrum

The life form spectrum is presented in Table 3. It indicates a distinct dominance of Therophytes (52%) that are favoured of the Mediterranean coastal ecosystems (Babalonas, 1979), followed by low participa-

TABLE 3. Life form spectrum

Phanerophytes	Chamaephytes	Hemicryptophytes	Geophytes	Therophytes	Helophytes
21	8	17	18	70	2

TABLE 4. Chorological spectrum

Mediterranean	Paleotemperate	European	Cosmopolitan	Other regions
94	14	6	7	15

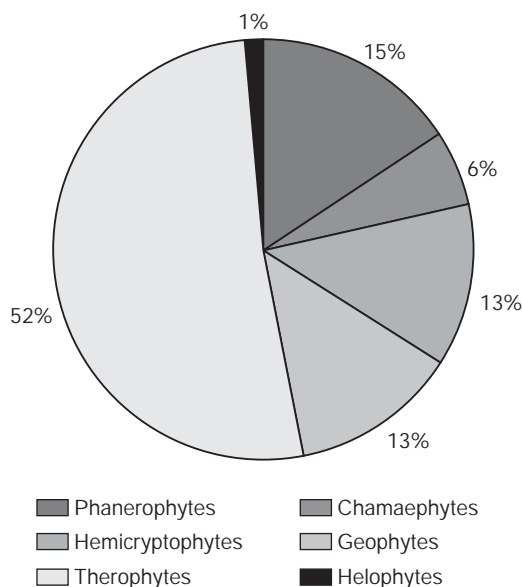


FIG. 4. Life form spectrum (percentages).

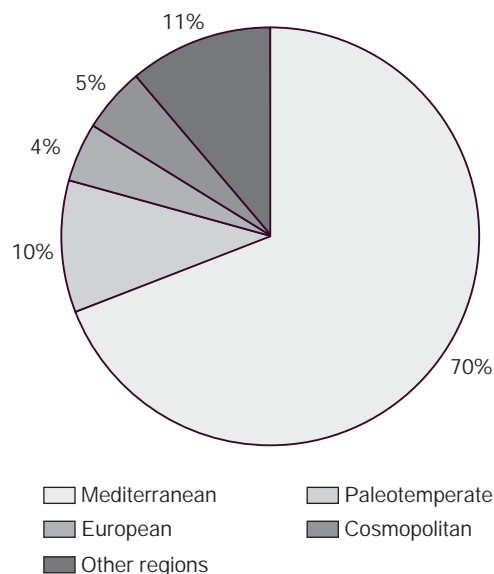


FIG. 5. Chorological spectrum (percentages).

tion of Phanerophytes (15%), Geophytes (13%) and Hemicryptophytes (13%) (Fig. 4).

Chorological spectrum

The chorological spectrum is presented in Table 4. It indicates an absolute dominance of the Mediterranean element (70%) and reveals the strong Mediterranean character of the vegetation. It is followed by low participation of the other chorological elements (Fig. 5).

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